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Diversity of Coccinellid beetles (Coccinellidae: Coleoptera) in Kashmir, India

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ABSTRACT: Survey was conducted on the diversity of coccinellid beetles in the horticultural ecosystems namely fruit orchards, vegetables and wild vegetation ecosystem of Kashmir during June 2014 to June 2015. Diversity indices like Shannon Weiener index; Simpson index; Margalef's index and Pielou index were used for studying diversity and abundance of coccinellid beetles. The results revealed that 1536 specimens of ladybird beetles collected, were identified into 3 sub families, 11 genera and 13 species. The diversity indices showed good diversity and rich fauna of coccinellids. The study brought the fact that the coccinellids are evenly distributed throughout the the study area. Comparison of abundance, species richness and diversity indices among fruit, vegetable and wild vegetation ecosystems revealed that coccinellid beetles diversity was more in wild vegetation and fruit ecosystems due to availability of prey as compared to vegetable ecosystem.

KEY WORDS: Diversity indices, Shannon Weiener index; Simpson index; Margalef's index and Pielou index, coccinellid beetles, agro-ecosystem, Kashmir

INTRODUCTION

Insects represent a dominant component of biodiversity in most terrestrial ecosystems and play a significant role in the ecosystem functioning (Weisser and Siemann, 2004). Loss of biodiversity is one of the major causes leading to environmental degradation. With the increase in population, there is more demand for food and it shows the importance of agricultural intensification. To improve the crop yield by using fertilizers and pesticides resulted in contamination and disturbance in natural ecosystems, ultimately harming biodiversity and community health (Hughes *et al*., 2002). Predation may increase the biodiversity of communities by preventing a single species from becoming dominant. It is obvious that predators depend on prey for survival, and this is reflected in predator populations being affected by changes in prey populations. Predators may be put to use in conservation efforts to control introduced species. Besides their use in conservation biology, predators are also important for controlling pests in agriculture. Natural predators are an environmental friendly and sustainable way of reducing damage to crops, and are one alternative to the use of chemical agents such as pesticides (Stanley, 2008).

Among predatory insects, Coccinellids are one of the most economically important groups and are very widespread in agriculture and forest ecosystems. They solely feed on a number of

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distantly related phytophagous insect pests of the agriculture and horticultural crops (Hodek and Honek, 1996; Omkar and Parvez, 2000). Coccinellids are also regarded as bio indicators (Iperti and Paoletti, 1999) and provide more general information about the ecosystem in which they occur (Anderson, 1999). They play their important role as bio control for those crops that are especially susceptible to aphid attack, namely maize, apple, vegetables, pear etc. Not only aphids, scales are also destructive pests of fruit orchards reducing fruit quality and quantity; these predators can significantly contribute in controlling these pests (Mulvany, 2002).

MATERIALS AND METHODS

In South Kashmir, India three districts were selected viz., district Anantnag (33° 43‘ N and 75° 09‘ E), Pulwama (33° 98‘ N and 75° 01‘ E) and Shopian (33° 71‘N and 74° 83‘E) (Fig.1). Survey was conducted from June 2014 to June 2015. Collection was done from horticultural ecosystems namely fruit orchards, vegetables and wild vegetation ecosystem of these regions.

Sampling methods: Sampling was conducted in different horticulture ecosystem of study area. Sampling was carried out from first week of June 2014 till late June 2015. Beetles were collected by net sweeping method and hand picking method (Jonathan, 1995). The net used for collection was made of white muslin cloth with long handle. Hand picking method was mostly adopted for collection. Sampling was done at fortnightly interval. Random sampling was done by choosing 10 fruit trees from each fruit orchard and 10 quadrants (1 square meter each) from cropland ecosystem from each location. The collected specimens were kept in collecting jars and collection tubes and brought to Entomology laboratory Department of Zoology, University of Kashmir for identification.

Identification: The collected specimens were identified with the help of available literature and taxonomic keys. The keys consulted during present study include Kapur (1956, 1958, 1963 and 1967) and Kuznetsov (1997).

Calculation of diversity indices: To calculate the diversity of ladybird beetles, following indices were used.

Shannon-Weiener index (Shannon, 1948).

$$H = -\sum_{i=1}^{s} (P_i \log_e P_i)$$

Where,

H = Shannon Weiener index

P_i = proportion of “i^{th}” species and is calculated as “ni/N”, where, “ni” is the number of individuals in “i^{th}” species and N is the total number of individuals in the sample.

$\text{Log}_e p_i$ = Natural log of P_i

Simpson’s index (D) (Simpson, 1949):

$$D = \text{sum } (P_i^2)$$

Simpson’s reciprocal diversity index = 1/D

Where,

P_i = proportion of “i^{th}” species and is calculated as “ni/N”, where, “ni” is the number of individuals in “i^{th}” species and N is the total number of individuals in the sample.

Margalef’s index (M_a) (Margalef, 1968, 1969) / Species Richness (Pielou, 1975).

$$M_a = S\text{-}1/\log_e N$$

Where,

S = number of species; N = total number of individuals; Loge = natural log

Species Evenness index (E) or (J) (Pielou, 1969)

$$E = H/\log_e S$$

Where,

H = Shannon - Weiener index; S = number of species; Log_e = natural log

RESULTS

During the present study 1536 specimens of ladybird beetles were collected from study sites, which were

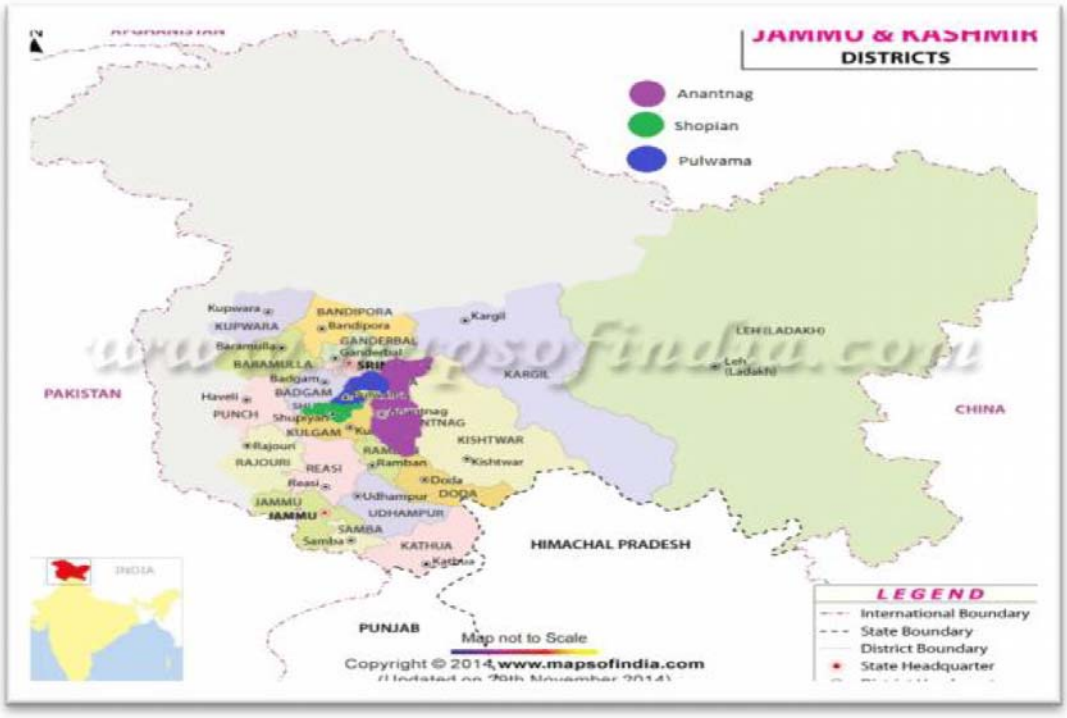

Fig.1. Map showing study sites

identified into 3 sub families, 11 genera and 13 species. Total number of specimens collected from district Anantnag was 555, from district Pulwama 522 and from district Shopian 459 (Table 1).

The calculated values of Shannon - Weiener index at different districts ranged from 2.33 (Anantnag) to 2.29 (Shopian). The lowest diversity index was calculated from district Shopian (2.29) and district

Table 1. Total number of specimens collected from three districts of South Kashmir

SPECIES	Total number of specimens collected			TOTAL
	ANANTNAG	PULWAMA	SHOPIAN	
Coccinella septempunctata	122	97	89	308
Chilocorus infernalis	105	99	90	294
Adalia tetraspilota	87	76	81	244
Hippodamia variegata	41	68	35	144
Oenopia conglobata	15	21	27	63
Coccinella transversalis	37	18	31	86
Coccinella undecimpunctata	30	15	39	84
Harmonia dimidiata	24	36	22	82
Macroilleis hauseri	26	19	09	54
Calvia punctata	25	41	12	78
Illeis indica	09	06	04	19
Henosepilachna vigintioctopunctata	16	14	12	42
Platynaspidius saundersi	18	12	08	38
Total = 13	555	522	459	1536

Pulwama (2.30). The highest value was from district Anantnag (2.33) (Table 2). The data computed by the Shannon Wiener index revealed that coccinellid beetles are more or less equally distributed at all districts because the calculated values did not show much difference among the three districts. Similarly, the calculated values of Simpson index ranged from 0.131(Shopian) to 0.093 (Pulwama). The lowest Simpson index was calculated from district Pulwama (0.093) and district Anantnag (0.129) whereas highest value was calculated from district Shopian (0.131). This index showed that lowest abundance was obtained from district Pulwama and Anantnag and highest abundance was obtained from Shopian. All the values obtained from this index showed that coccinellid beetles abundance is more or less same for all the districts surveyed during present work. Similarly Simpson's reciprocal diversity index ranged from 10.73 (Anantnag) to 7.63 (Shopian) (Table 2).

The calculated values of Margalef's index ranged from 1.95 (Shopian) to 1.89 (Anantnag). The lowest value was obtained from district Anantnag (1.89) and district Pulwama (1.92) and highest from district Shopian (1.95). This indicates that species richness was slightly higher at Shopian district. Likewise the calculated values for species evenness ranged from 10.73 (Pulwama) to 7.63 (Shopian) (Table 3).

Table 3. Calculated values of Evenness and Richness at three districts

Location	Evenness	Richness
Anantnag	0.910	1.89
Pulwama	0.898	1.92
Shopian	0.895	1.96

Table 2. Calculated values of diversity indices of three districts

Study sites	Shannon Wiener Index	Simpson Index	Simpson Reciprocal Index	Simpson Index of Diversity
Anantnag	2.33	0.129	7.75	0.871
Pulwama	2.30	0.093	10.73	0.906
Shopian	2.29	0.131	7.63	0.868

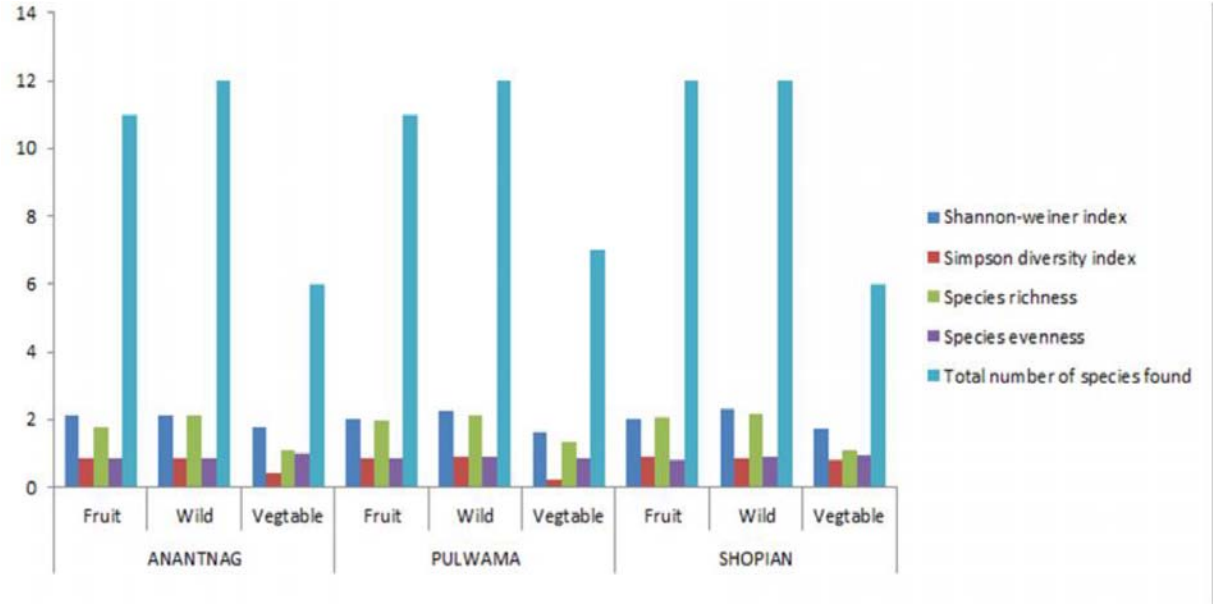

Fig. 2. Graph showing diversity indices among three ecosystems

Table 4. Diversity indices of ladybird beetles in fruit, vegetable and wild vegetation ecosystems at three sites

Diversity indices	ANANTNAG			PULWAMA			SHOPIAN		
	Fruit	Wild	Vegetable	Fruit	Wild	Vegetable	Fruit	Wild	Vegetable
Shannon - Weiener index	2.11	2.12	1.76	2.02	2.25	1.62	2.01	2.29	1.72
Simpson diversity index	0.84	0.85	0.42	0.83	0.88	0.22	0.88	0.86	0.81
Species richness	1.78	2.12	1.09	1.98	2.13	1.34	2.05	2.16	1.11
Species evenness	0.87	0.87	0.98	0.84	0.9	0.83	0.81	0.92	0.96
Total species (no.)	11	12	6	11	12	7	12	12	6

Different diversity indices were also applied to three different ecosystems in each district for calculating the diversity of Coccinellid beetles in particular ecosystem. The three ecosystems include fruit, vegetable and wild vegetation ecosystems. Table 4 showed the calculated values of different indices on these three ecosystems. The values obtained from the indices showed that fruit ecosystem and wild vegetation have diverse assemblage of coccinellids as compared to vegetable ecosystem (Fig.2). They were also found to support higher number of coccinellid species. In all, 11 species of coccinellids was found in fruit ecosystem of district Anantnag and Pulwama while as in Shopian 12 species was found. Likewise in Wild vegetation 12 species was found from all the three districts. In Shopian district and Anantnag 6 species was found from Vegetable ecosystem and 7 species in district Pulwama.

Also during the present study, the most encountered species was *Coccinella septempunctata.* It was found dominating species from all the three districts and abundantly present in all the three ecosystems. Very interestingly *Henosepilachna vigintiocto-punctata* showed narrow range of habitat and was collected only on vegetable ecosystem. On the other hand *Chilocorus infernalis* was absent in vegetable ecosystem in all three districts and show dominance on fruit ecosystem and wild vegetation.

DISCUSSION

The results obtained during present study showed the diversity of coccinellid beetles in horticulture ecosystem in south Kashmir. Raghuraman *et al*. (2005) studied the diversity of coccinellids in agricultural and Horticultural crop in Madurai and Theni of Tamil Nadu, a total of 19 species of predatory coccinellids were recorded. Similarly Abas *et al*. (2013) studied the diversity and distribution of ladybird beetles in the cropland of Faisalabad district, a total of 2204 specimens of coccinellids were collected belonging to four subfamilies, nine genera and 12 species. Bhagat *et al.* (1988) reported 12 species of Coccinellid beetles from apple orchards of Jammu and Kashmir. Azim and Bhat (2005) published the taxonomic notes of 8 coccinellid beetles from Kashmir, 2 species from subfamily Chilocorinae and six from subfamily Coccinellinae. Sathe and Bhosale (2001) reported 21 species of ladybird beetles feeding on aphids and several soft-bodied homopterous pests of agricultural and forests plants from Maharashtra. The different diversity indices used during present study was similar to that of indices used by Hayat and Khan (2013) and Biranvand *et al*. (2014). The present results showed rich diversity of ladybird beetles in fruit ecosystem and wild vegetation as compared to vegetable ecosystem. These findings are in accordance with those of Shah and Khan (2014) and Khan *et al*. (2007 a, b).

The study showed great diversity and rich fauna of coccinellid beetles in the South Kashmir recording 13 different species belonging to 11 genera and 3 subfamilies. The various diversity indices like Shannon - Weiener index, Simpson index; Margalef's index and Pielou index showed that the

species recorded during the present study are evenly distributed throughout the study area. Comparison of abundance, species richness and diversity indices among fruit, vegetable and wild vegetation ecosystems revealed that coccinellid diversity was more in wild vegetation and fruit ecosystems due availability of prey as compared to vegetable ecosystem which are of short duration. Thus it can be suggested that fruit and wild vegetation can act as important natural habitats of coccinellid predators as they were found to support higher number of coccinellid beetles. The ability of these coccinellid beetles to be so successful in a large range of habitats makes it especially beneficial to humans who need crop security from aphid infestations.

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